SOUTHEASTERN SPECIES OF THE MAYFLY SUBGENUS *SERRATELLA* (*EPHEMERELLA:* EPHEMERELLIDAE)[1]

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Presently three species of the subgenus *Serratella* of the genus *Ephemerella* are known to occur in the southeastern United States. We are describing two new species, reporting two additional ones from this region, and discussing the other three. *Ephemerella serrata* Morgan, a boreal species, ranges southward into the Appalachian highlands of North Carolina, while the range of *E. deficiens* Morgan, reported as *Ephemerella* sp. A by Berner (1950, 1958), continues as far south as northern Florida. The range of *E. serratoides* McDunnough is also greatly increased as a result of our findings. To these records, we now add the occurrence of *E. sordida* McDunnough and *E. frisoni* McDunnough in the southeast. Both of the new species, described below, have been collected in North Carolina and Tennessee.

The subgenus *Serratella* is widely distributed in North America, occurring from coast to coast over most of the continent. Records from the central area are still scarce, probably due to unsatisfactory ecological situations for the nymphs, a stage which is dependent on flowing water. The ranges of six of the seven species reported here overlap in the southeast with the Appalachians being the common meeting ground. *Ephemerella deficiens*, the most adaptable of the species, is most widely dispersed.

The nymphs of all the species require essentially similar habitats and their behaviors are alike. All require swiftly-flowing streams, generally where there are rocks, and the nymphs live either in rock crevices or in dense mats of vegetation where they are well protected from the force of the current.

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Ephemerella (Serratella) carolina n. sp.

Traver. 1932. Jour. Elisha Mitchell Sci. Soc., 47(2): 178 (*Ephemerella* sp?, No. 2).

MATURE NYMPH. Length: body 4.5-5.0 mm.; caudal filaments 1.5-2.0 mm. *Head* brown with variable darker brown markings, well-developed occipital tubercles covered with fine spicules in both male (Fig. 2) and female, maxillary palpi reduced and unsegmented (Fig. 10). *Thorax* brown

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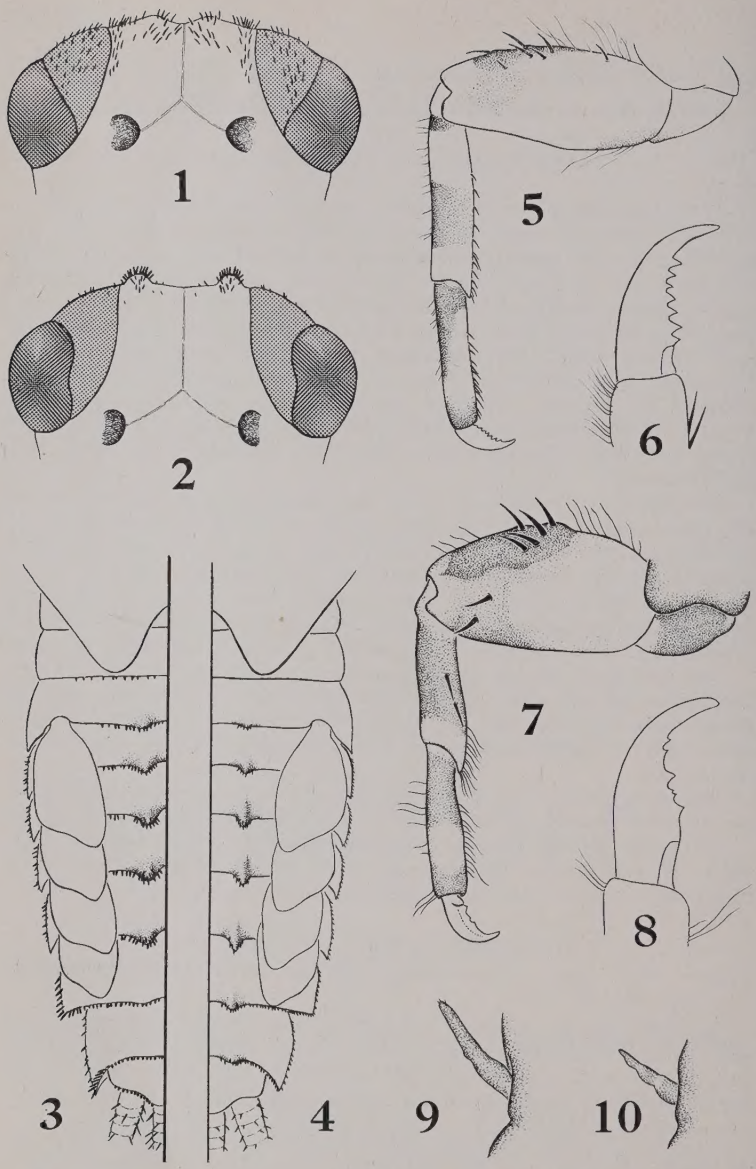

Fig. 1. *Ephemerella spiculosa,* vertex of nymphal head. Fig. 2. *E. carolina,* vertex of nymphal head. Fig. 3. *E. spiculosa,* half of abdominal terga of mature nymph. Fig. 4. *E. carolina,* half of abdominal terga of mature nymph. Figs. 5-6. *E. spiculosa,* fig. 5. right nymphal foreleg, fig. 6. tarsal claw. Figs. 7-8. *E. carolina,* fig. 7. right nymphal foreleg, fig. 8. tarsal claw. Fig. 9. *E. spiculosa,* maxillary palp. Fig. 10. *E. carolina,* maxillary palp.

with variable dark-brown and pale markings. Pronotum usually brown with a dark-brown, submedian macula, antero-lateral portion pale, enclosing a dark-brown mark; paired, submedian tubercles covered with fine spicules. Mesonotum brown with variable dark-brown and pale markings; paired, submedian tubercles, and a single posterior median tubercle all covered with fine spicules. Legs pale with brown markings; forefemora as in Fig. 7; middle and hind femora with an entire or interrupted brown, transverse band in basal third; tibiae with a variable dark-brown band near the middle; tarsi with proximal and distal bands; tarsal claws with 5-7 denticles (Fig. 8). *Abdominal* terga brown with dark-brown and pale markings; terga 4-6 usually pale while terga 7-9 are usually dark-brown to black; paired, dorsal, submedian tubercles on segments 3-9, tubercles on segments 4-8 well developed, those on segments 3 and 9 often reduced (Fig. 4); posterior margins of terga 8 and 9 only with numerous fine spicules; abdominal sterna reddish-brown, with darker, reddish-brown, lateral margins, or abdominal sterna unicolorous dark-brown. Caudal filaments pale with variable dark-brown, transverse bands.

HOLOTYPE: ♂ nymph, Buck Creek, Macon Co., N. C., Aug. 6, 1948, Lewis Berner, No. 3184.5, U. of Fla. collections.

PARATYPES: *North Carolina:* 7 ♂ and 3 ♀ nymphs, Great Smoky National Park, Oconaluftee River, July 25, 1957, L. B., 2 ♂ and 1 ♀ nymphs in collection of U. of Utah, 5 ♂ and 2 ♀ nymphs, No. 3983.0, in collection of U. of Fla; 1 ♀ nymph, 1 mile west of Wayah Gap, Macon Co., July 29, 1957, L. B., No. 3987.3, in collection of U. of Fla.; 5 ♀ nymphs, Wayah Creek, Macon Co., Aug. 21, 1955, L. B., 2 nymphs in collection of U. of Utah, 3 nymphs, No. 3674.1, in collection of U. of Fla.; 5 ♂ and 4 ♀ nymphs, Wayah Creek, Macon Co., Aug. 17, 1960, L. B., 1 ♂ and 1 ♀ nymph in collection of U. of Utah, 4 ♂ and 3 ♀ nymphs, No. 4261.0, in collection of U. of Fla.; 1 ♀ nymph, 0.9 mi. from Hq., Coweeta Exp. Forest, Macon Co., July 30, 1957, S. and D. Mulaik, in collection of U. of Utah; 3 ♂ nymphs, Buck Creek, Macon Co., Aug. 19, 1948, L. B., No. 3187.19, in collection of U. of Fla.; 1 nymph, Paceolet River, Polk Co., July 27, 1955, L. B., No. 3764.6, in collection of U. of Fla.; 1 ♀ nymph, Indian Creek, Swain Co., Aug. 20, 1954, L. B., No. 3621.3, in collection of U. of Fla.; 1 ♀ nymph, Davidson River, June 30, 1930, in private collection of J. R. Traver, Amherst, Mass.; 3 ♀ nymphs, Smokemont, Aug. 2, 1930, H. T. Spieth, in collection of Amer. Mus. Nat. Hist.; 1 ♂ nymph, Smokemont, Aug. 3, 1930, H. T. Spieth, in collection of Amer. Mus. Nat. Hist. *Tennessee:* 1 ♂ nymph, Elkmont, Aug. 11, 1930, H. T. Spieth, in collection of Amer. Mus. Nat. Hist.

TAXONOMY

The nymphs of *Ephemerella carolina* appear to be most closely related to those of *E. serrata* Morgan and *E. spiculosa* n. sp. as they all possess paired, submedian, prothoracic tubercles. The nymphs of *E. carolina* may be readily distinguished from the nymphs of *E. serrata* and *E. spiculosa* and all other known species of the *Serratella* as they possess well-developed, paired, occipital tubercles (Fig. 2). The nymphs of *E. carolina* may be further distinguished from all other species of the subgenus by the number and development of the paired, submedian abdominal tubercles (Fig. 4), the development and shape of the maxillary palpi (Fig. 10), the shape,

coloration, and armature of the foreleg (Fig. 7), and the dentition of the tarsal claws (Fig. 8).

Biology

The nymphs of *E. carolina* seem to be restricted to streams at an altitude of not less than 2500 feet elevation. The range of the species is evidently limited as all collections are confined to North Carolina, except that of Spieth from Elkmont in the Great Smokies National Park. The rarity of the nymphs is attested by the scarcity of specimens in numerous collections from the mountainous regions of North Carolina and Tennessee, and their absence from those of South Carolina and Alabama.

Nine nymphs were collected in August, 1960, from Wayah Creek, and at this time it was a rocky-bottomed stream varying from 8-12 inches in depth and about 20 feet in width. Coarse sand was interspersed among the rocks and part of the bed was made up of this coarse material. Vegetation was sparse except for algae growing in small masses in the slowly flowing parts of the stream. Stream flow was moderate to swift, as in most mountain streams of this region, and the water was clear, colorless, and about 72°F.

Nymphs of *E. carolina* were taken from the rocks in the stream bed by use of a net held downstream while the rocks were vigorously disturbed. Nymphs probably rest on the downstream side of the rocks or in crevices where they are well protected from the current. Their movements were slow and deliberate when taken from the water and resemble those of *E. deficiens*, a closely related species. Because of the mature state of the nymphs taken at Wayah Creek, we estimate emergence of adults occurs in late August or early September.

Ephemerella (Serratella) spiculosa n. sp.

Mature Nymph: Length: body 4.0-4.6 mm.; caudal filaments 1.7-2.0 mm. *Head* brown with a dark-brown mark near each lateral ocellus; without occipital tubercles; top of head with numerous, fine spicules (Fig. 1); labrum dark-brown; maxillary palpi reduced, unsegmented, and with fine apical spicules (Fig. 9). *Thorax* with brown markings, covered with fine spicules. Prothorax with two small, submedian tubercles covered with fine spicules, suture between pronotum and mesonotum dark-brown. Mesonotum pale with brown markings, covered with fine spicules, two submedian, brown marks, two sublateral, dark-brown dots, and a dark-brown, V-shaped mark which follows the mesal margin of each wing pad. Legs pale with brown markings; forefemora marked as in Fig. 5; middle and hind femora with a brown band in basal third; tibiae with a proximal, brown mark and a median, brown band; tarsi with a proximal, brown band and a distal, brown mark; tarsal claws with 6-8 denticles (Fig. 6). *Abdominal* terga light-brown with dark-brown, nerve-like lines; terga 1-3 with two wide, submedian, dark-brown stripes; paired, dorsal, submedian tubercles on segments 3-7 covered with fine spicules; segments 2, 8, and 9 with slight undulations (Fig. 3); posterior margins of segments 8-10 with numerous, fine spicules. Abdominal sterna pale with brown, posterior margins; sterna 3-7 with darker-brown, sublateral marks; sternum 9 with a few, fine spicules. Caudal filaments pale with dark-brown, transverse bands.

HOLOTYPE: ♂ nymph, Horse Creek Recreation Area, Green Co., Tennessee, Aug. 3, 1956, C. D. Hynes, No. 3829.6, in collection of U. of Fla.

PARATYPES: *North Carolina:* 2 ♀ nymphs, Macon Co., Skittles Creek, July 16, 1957, C. D. Hynes, No. 3974.0, in collection of U. of Fla.

TAXONOMY

Ephemerella spiculosa is most closely related to *E. carolina* and *E. serrata* Morgan. The nymphs of all of these species have paired, submedian, prothoracic tubercles and fine spicules on the body segments. These nymphs may be readily separated as *E. carolina* has well developed occipital tubercles, *E. serrata* has small suboccipital tubercles, while the head of *E. spiculosa* lacks them. The nymphal heads of *E. carolina* and *E. serrata* have only a few scattered spicules, while the nymphal head of *E. spiculosa* is clothed with numerous fine spicules (Fig. 1). *Ephemerella spiculosa* may further be distinguished from these species and all others of the subgenus *Serratella* by the dentition of the tarsal claws (Fig. 6), the development and shape of the maxillary palpi (Fig. 9), the number and development of the paired, submedian, abdominal tubercles (Fig. 3), and the shape, coloration, and armature of the foreleg (Fig. 5).

BIOLOGY

A single nymph of *E. spiculosa* was taken from Horse Creek, a small stream near Greenville, Tennessee. At the time the collection was made, the stream varied from 6-12 inches in depth and 3-6 feet in width and is fairly typical of those found in the mountains of eastern Tennessee. The bottom was composed of bedrock covered with sand and contained numerous loose rocks and large boulders. During the fall of the year, the creek dries up to a series of pools, leaving the stream bed completely dry in some places (Wright and Berner, 1949). Although Dr. Mike Wright and his students collected extensively in the mountain streams of eastern Tennessee, they apparently took no specimens of *E. spiculosa* as all of their nymphs were sent to one of us (Berner) for identification and none of this species appeared in their collections.

It is likely that the nymphs of *E. spiculosa* hide in rock crevices or protected places in the stream much as do other members of the subgenus *Serratella*. Confirmation of this type of habitat is provided by the site of the second collection from North Carolina. Here the rocks from which the nymphs were collected had much moss and silt on them, yet the water was swiftly flowing.

This species, as is the case with *E. carolina*, has been found only in the mountainous areas of the Southeast. It probably requires cold, swiftly-flowing water for development.

Ephemerella (Serratella) sordida McDunnough

This species, described from Quebec by McDunnough (1925), was subsequently reported from Ontario by Ide (1930). The collections listed below extend the range of *E. sordida* through the Appalachians into Virginia, North Carolina, Tennessee, and southward into the northern Coastal Plain of Alabama.

The nymphs of *E. sordida* occurred in swiftly flowing streams varying in size from 15 feet in width and rather shallow to large rivers such as the Cahaba in Alabama. The nymphs lived in crevices or in protected places on loose rocks in the stream bed. Although generally there was moss growing on the surface of the stones, nymphs of this species apparently did not live in it.

LOCALITY RECORDS: (all specimens in University of Florida collections) *Alabama:* Perry Co., Cahaba River, May 10, 1955, C. D. Hynes, 1 nymph, No. 3710.0; Walker Co., Black Water Creek, June 14, 1954, C. D. Hynes, 25 nymphs, No. 3492.15, 10 ♂, 10 ♀ adults, No. 3492.6. *North Carolina:* Macon Co., Highlands, July 19, 1957, C. D. Hynes, 1 ♂ adult, No. 3979.0. *Tennessee:* Cumberland Co., 10.5 miles N.W. of Rhea-Cumberland Co. line, Tenn. Hwy. 68, July 27, 1956, C. D. Hynes, 1 nymph, No. 3810.6. *Virginia:* Montgomery Co., Radford Arsenal, June 3-7, 1957, R. L. Hoffman, 3 ♂, 3 ♀ adults, No. 4001.0; same data, mid-August, 1951, R. L. H., 3 ♂, 1 ♀ adults, No. 3998.2.

Ephemerella (Serratella) frisoni McDunnough

Ephemerella frisoni, previously known only from Illinois and Missouri (Burks, 1953), has been taken in the northwestern corner of Alabama. The nymphs occurred in a swiftly-flowing, large stream, varying from rather shallow to quite deep. The creek bottom was composed of bedrock with loose stones scattered over it. There was a heavy deposit of silt over the stones and many of them had vegetation attached. It was in the vegetation that the nymphs of *E. frisoni* occurred commonly. The plants grew most profusely not more than six inches below the surface, although they could be found growing well as far down as one foot. The single adult male was taken at light shortly after dark.

LOCALITY RECORDS: (all specimens in U. of Fla. collections) *Alabama:* Lauderdale Co., Cypress Creek at northern city limits of Florence, June 10, 1956, L. B. and C. D. Hynes, 1 ♂ adult, No. 3879.6, 30 nymphs, Nos. 3878.8 and 3878.13.

Ephemerella (Serratella) serrata Morgan

During our years of collecting in the streams of the Southeastern United States, we have not encountered *Ephemerella serrata,* although the closely related *E. carolina* has been found in many places in the Appalachian highlands. *E. serrata* is widely distributed through the eastern part of North America, having been reported by Morgan (1911) from New York and Massachusetts, Quebec by McDunnough (1931), and from Maryland, West Virginia, and three stations in the Appalachian region of North Carolina by Traver (1935).

Presently, we have adult males and females which may be either *E. serrata* or *E. carolina* but we will not be able to name them with certainty until we have an opportunity to obtain reared specimens for comparison. We are, therefore, not including these records in this paper.

Ephemerella (Serratella) serratoides McDunnough

Ephemerella serratoides is a widely distributed species ranging from Quebec, Ontario, Nova Scotia, and New Brunswick southwards as far as

southern Georgia. In the southeast, the species was found in the mountains, the piedmont, and the coastal plain.

Periods of emergence of adults show a considerable degree of variation as we have mature nymphs from Tennessee taken in April which would have emerged late that month or in early May, while specimens from northern Georgia collected in mid-August included many which would not have emerged until September. In addition, the northern Georgia collection includes half-grown nymphs which likely would have emerged the following spring. McDunnough's (1931) adult specimens were collected from mid-July to mid-August. Our earlier as well as later emergence dates are probably a reflection of the higher water temperatures in the southern streams.

The nymphs of *E. serratoides* were generally found in swiftly-flowing, rocky-bottomed streams. Many of the rocks in these streams were moss-covered on their upper surfaces and nymphs of *Ephemerella* occurred buried in these masses of vegetation. When the rocks were removed from the stream and the water allowed to drain away, the nymphs began to crawl upward and were easily detected. The mosses grew in shallow water and the nymphs, therefore, were only a few inches below the water surface. Because of the denseness of the plants, the nymphs were protected from the force of the current and could move about freely near the base of the plants where they fed. Movements were slow and deliberate as is true of all members of the subgenus *Serratella.*

The Ichawaynochaway Creek, a tributary of the Flint River in southern Georgia, is a swiftly-flowing, deep stream coursing over a limestone bed. Rocks are strewn over the bottom which is overlaid with coarse sand. Cypress trees formerly grew at the banks where collections were made but they have now been cut with only the stumps remaining. Mosses grow profusely on the upper surfaces of the rocks as well as on the submerged parts of the tree stumps and it was in these habitats that the nymphs of *E. serratoides* were found.

At the Etowah River, also in Georgia, the nymphs were found in numbers living near the bases of the riverweed, *Podostemum ceratophyllum* Michx. These specimens were collected by removing rocks to which the plant was attached, allowing the water to drain away, and watching the nymphs as they climbed about in the drying plant. The Etowah, in the region where the collections were made, is a swiftly-flowing stream, approximately 150 feet wide and shallow. The bottom is sandy with rocks scattered over it.

Locality Records: (all specimens in University of Florida collections) *Alabama:* Coosa Co., 11.8 miles s. of Coosa-Talladega County line, Hwy. 231, June 19, 1954, C. D. Hynes, 15 nymphs, No. 3504.0; Shelby Co., Davis Creek west of Montevallo, June 18, 1954, CDH, 8 nymphs, No. 3502.1 *Georgia:* Baker Co., Ichawaynochaway Creek at Hwy. 91, May 15, 1954, L. Berner, 6 nymphs, No. 3471.0; Cherokee Co., Etowah River near Gober, June 20, 1956, CDH, 8 nymphs, No. 3902.21, June 23, 1955, CDH and LB, 50 nymphs, No. 3716.11, July 30, 1954, CDH, 6 nymphs, No. 3609.5, Aug. 18, 1956, CDH, 3 nymphs, No. 3823.3; Lumpkin Co., Chestatee River at Hwy. 52, Aug. 13, 1955, CDH and LB, 30 nymphs, No. 3714.10, Yahoola Creek near Dahlonga, July 20, 1955, CDH, 7 nymphs, No. 3762.4, Aug. 19, 1956, CDH, 2 nymphs,

No. 3824.4. Pickens Co., Hwy. 5, 1.7 miles s. of junction with Hwy. 136, June 21, 1956, CDH, nymphs, No. 3903.5. *North Carolina:* Graham Co., Santeetlah Creek, Joyce Kilmer Forest road, Aug. 18, 1954, LB, 2 nymphs, No. 3618.0; Macon Co., Franklin, July 9, 1957, CDH, 1 ♂, 8 ♀ adults, No. 3972.1, Big Creek near Highlands, Aug. 2, 1948, LB, 3 nymphs, No. 3178.1, Buck Creek, Aug. 9, 1948, LB, 1 nymph, No. 3187.18, Nantahala River, Aug. 16, 1954, LB, 25 nymphs, No. 3615.3, Aug. 21, 1954, LB, 15 nymphs, No. 3623.3, Ellijay Creek at Hwy. 90, Aug. 21, 1955, CDH and LB, 1 nymph, No. 3673.7; Polk Co., Paceolet River, July 27, 1955, CDH and LB, 15 nymphs, No. 3764.7; Randolph Co., 3.5 miles s. of Coleridge at Hwy. 22, July 5, 1955, CDH, 2 nymphs, No. 3733.9; Swain Co., Smokemont, June 25, 1957, CDH, 1 ♀ adult, No. 3961.7, Deep Creek at Bryson City, Aug. 15, 1954, LB, 25 nymphs, No. 3613.14, Cherokee, July 8, 1957, CDH, 1 ♂ adult, No. 3969.3; Transylvania Co., Hwy. 276 s. of Brevard, June 17, 1955, CDH, 2 nymphs, No. 3581.4; Union Co., Richardson Creek at Hwy. 218, July 7, 1955, CDH, 1 nymph. *South Carolina:* Greenville Co., North Saluda River at Hwy. 11, Aug. 5, 1955, CDH, 3 nymphs, No. 3856.6; Laurens Co., South Rabon Creek at Hwy. 76, June 9, 1955, CDH, 50 nymphs, 1 ♂ subimago, No. 3562.0. *Tennessee:* Franklin Co., 11.4 miles w. of Winchester, Hwy. 64, April 13, 1954, Jean Pugh, 5 nymphs, No. 3421.0; Robertson Co., 7 miles e. of Clarkesville at Hwy. 76, June 16, 1956, CDH, 1 nymph, No. 3885.7; Sevier Co., Pigeon Forge, July 24, 1957, CDH, 2 ♀ adults, No. 3981.8, Little Pigeon River, Aug. 5, 1956, CDH, 2 nymphs, No. 3833.10, Hwy. 411, 21 miles w. of junction with 25 E, Aug. 5, 1956. CDH, 1 nymph, No. 3834.7; Unicoi Co., Washington-Unicoi County line at Hwy. 107, Aug. 6, 1956, CDH, 15 nymphs, No. 3835.5.

Ephemerella (Serratella) deficiens Morgan

Berner. 1950. Univ. Fla. Studies, Biol. Sci. Ser., 4(4): 160 (*Ephemerella* sp. A).

The widely distributed *Ephemerella deficiens* was reported as *Ephemerella* sp. A by Berner (1950, 1958) from northwestern Florida, Georgia, and Alabama. The species ranges over a vast territory, having been reported from New York, Quebec, Ontario, New Brunswick, Nova Scotia, New Hampshire, North Carolina, Massachusetts, Michigan, West Virginia, Virginia, Alabama, Georgia, and Florida. There appears to be no correlation between the distribution of the species and the physiographic regions of eastern North America in which it occurs. Those factors limiting the distribution of *E. deficiens* are probably temperature and rate of stream flow, the nymphs requiring moderately to swiftly-flowing water.

The biology of the nymphs of this species was discussed by Berner (1950). Supplementary data confirm earlier findings. In the streams of the piedmont and the mountains, the nymphs live side by side with those of *E. serratoides* sharing identical habitats.

Locality Records: (all specimens in University of Florida collections unless otherwise stated) *Alabama:* Bibb Co., Cahaba River north of Centerville, May 12, 1955, C. D. Hynes, 25 nymphs, No. 3712.6, June 16, 1954, CDH, 4 nymphs, No. 3496.9, June 22, 1956, CDH, 8 nymphs, 5 ♀ adults, No. 3905.8, Shultze's Creek north of Centerville, June 17, 1954, CDH, 4 nymphs, No. 3497.0; Coosa Co., 11.8 miles s. of Coosa-Talladega Co. line, June 19, 1954,

CDH, 10 nymphs, No. 3504.10; Covington Co., 11.4 miles e. of Brooklyn, July 13, 1954, CDH, 4 nymphs, No. 3515.1; Dallas Co., 2.9 miles s. of junction of Hwy. 100 and Hwy. 43, on Hwy. 43, June 23, 1956, CDH, 1 nymph; Elmore Co., Martin Dam road, 1.9 miles s. of Red Hill, June 10, 1954, CDH and L. Berner, nymphs, No. 3477.5; Lauderdale Co., Cypress Creek at Florence, June 10, 1956, CDH and LB, 35 nymphs, No. 3878.7, July 18, 1956, CDH, 1 nymph, No. 3826.5, 5.2 miles west of turnoff to lock four, Wilson Dam, July 27, 1954, CDH, 4 nymphs, No. 3603.0; Macon Co., Uphappee Creek north of Tuskagee, June 9, 1954, CDH and LB, nymphs, No. 3475.16; Mobile Co., 2.1 miles s. of Kushla, June 3, 1940, LB, 13 nymphs, No. 1481.4, Seabury Creek s. of Kushla, June 3, 1940, LB, 2 nymphs, No. 1482.6; Shelby Co., Davis Creek w. of Montavallo, June 18, 1954, CDH, 15 nymphs, No. 3502.0; Tusaloosa Co., Creek on Hwy. 43, 5.8 miles n. of intersection with Hwy. 171, April 15, 1956, CDH and LB, 4 nymphs, No. 3788.4, Gin Creek 12 miles n. of Tuscaloosa, May 11, 1955, 1 nymph, No. 3711.5, 15.6 miles s. of Tuscaloosa-Fayette Co. line on Hwy. 43, June 16, 1954, 6 nymphs, No. 3495.3. *Florida: (all records prior to 1951 listed by Berner, 1950, and not repeated here)* Gadsden Co., 4½ miles s. River Junction, April 4, 1953, LB, nymphs, No. 3301.5; Liberty Co., Crooked Creek 10 miles s. River Junction, March 27, 1954, LB, 1 nymph, No. 3402.2, Sweetwater Creek, May 14, 1951, LB, 6 nymphs, 3 ♀ adults, No. 3336.3. *Georgia:* Cherokee Co., Etowah River near Gober, June 23, 1955, CDH and LB, 3 nymphs, No. 3716.10, Aug. 18, 1956, CDH, 4 nymphs, No. 3823.4, Etowah River at Canton, July 30, 1954, CDH, 6 nymphs, No. 3609.4; Decatur Co., Mosquito Creek at Hwy. 97, April 5, 1953, LB, nymphs, No. 3317.2; Early Co., 1.9 miles e. of Saffold, Feb. 2, 1949, I. J. Cantrall and LB, nymphs; Fulton Co., 10 miles n. of Atlanta, April 28, 1938, LB, 1 nymph, No. 1187.1; Lumpkin Co., Chestatee River at Hwy. 52, Aug. 13, 1955, CDH and LB, 6 nymphs, No. 3714.7; Peach Co., Mossy Creek, 4 miles n. Perry, April 10, 1954, CDH and LB, 10 nymphs, No. 3406.0; Pickens Co., Hwy. 5, 1.7 miles s. of junction with Hwy. 136, June 21, 1956, CDH, nymphs, No. 3903.3; Pike Co., Flat Shoals, 6 miles w. Concord, April 21, 1933, P. W. Fattig, 2 nymphs (Emory University collections); Wilkes Co., 5 miles e. Tignall, July 14, 1955, CDH, 2 nymphs, No. 3754.6. *Mississippi:* Lauderdale Co., Don's Falls s. of Meridian, July 14, 1954, CDH, 5 nymphs, No. 3519.3; Pike Co., Tangipahoa River at Hwy. 51, Aug. 19, 1954, CDH, 2 nymphs, No. 3646.6. *North Carolina:* Davidson Co., South Fork Creek at Hwy. 150, July 6, 1955, CDH, 1 nymph; Jackson Co., Hurricane Creek, June 13, 1955, LB, 2 nymphs, No. 3538.2; Macon Co., Middle Creek, 8 miles s. of Highlands, Aug. 11, 1948, LB, 1 nymph, No. 3192.6; Swain Co., Oconoluftee River at Smokemont, May 28, 1934, T. H. Frison (Illinois Natural History Survey), June 25, 1957, CDH, 2 ♂ adults, No. 3961.6; Transylvania Co., Hwy. 276 s. of Brevard, June 17, 1955, CDH, 35 nymphs, No. 3581.6, Pisgah National Forest at Hwy. 276, July 30, 1957, CDH, 4 ♀ adults, No. 3988.0. *South Carolina:* Aiken Co., Dikes above Ellenton, no date, T. Dolan and S. S. Roback, nymphs (identified by J. R. Traver and in collection of Academy of Natural Sciences of Philadelphia); Anderson Co., Hwy. 76 n. of Anderson, June 8, 1955, CDH, 1 nymph, No. 3560.3; Edgefield Co., 6.1 miles n. of North Augusta at Hwy. 230, July 13, 1955, CDH, 1 nymph, No. 3752.6; Fairfield Co., Parr, April 19, 1955, CDH and LB, 4 nymphs, No. 3704.1; Greenville Co., Hwy. 14, 1.5 miles n. of junction

with Hwy. 29, Aug. 3, 1955, CDH, 1 nymph, North Saluda River at Hwy. 11, Aug. 5, 1955, CDH, 50 nymphs, No. 3856.4, Aug. 20, 1955, CDH, 10 nymphs No. 3865.3. *Tennessee:* Hawkins Co., 9 miles w. of Church Hill, Aug. 2, 1956, CDH, 15 nymphs, No. 3828.1; Polk Co., Hwy. 30, 1.7 miles n. of Junction with Hwy. 64, Aug. 11, 1956, CDH, 4 nymphs, No. 3817.0; Sevier Co., Gatlinburg, Fighting Creek, May 27, 1934, T. H. Frison, nymphs (in collection of Illinois Natural History Survey), Pigeon Forge, July 24, 1957, CDH, 1 ♂ adult, No. 3981.9, Little Pigeon River, Aug. 5, 1956, CDH, 2 nymphs, No. 3833.9, Hwy. 411, 21 miles w. of junction with Hwy. 25 E, Aug. 5, 1956, CDH, 3 nymphs, No. 3834.8; Unicoi Co., Hwy. 107 at Washington-Unicoi county line, Aug. 6, 1956, 1 nymph, CDH, No. 3835.6.

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PARASITISM OF PURPLE SCALE IN FLORIDA CITRUS GROVES [1]

MARTIN H. MUMA [2] AND D. W. CLANCY [3]

Early studies on natural control of purple scale, *Lepidosaphes beckii* (Newman), in Florida stressed the importance of the so-called "friendly fungi," *Sphaerostilbe aurantiicola* (Berk and Br.), *Nectria diploa* Berk and Curt., *Podonectria coccicola* (Ell. and Ev.), *Myriangium floridanum* Hoehm, and *Verticillium cinnamomeum* Petch. However, the results of later investigations by Holloway and Young (1943), Fisher, Thompson, and Griffiths (1949), Ziegler (1949), and Fisher (1950a) (1950b) indicated that these fungi were saprophytic. Concurrently, Fisher (1948), Fisher et al. (1949), and Fisher (1950a) reported two species of endoparasitic fungi, *Myiophagus* sp. and *Hirsutella besseyi* Fisher, attacking purple scale in Florida. The former causes a disease of mature and immature scales known as chytridiosus. The latter is associated with a yeast-like disease of scale crawlers.

Three species of parasitic Hymenoptera, *Aspidiotiphagus lounsburyi* (B. and P.), *A. citrinus* (Craw) and *Prospaltella aurantii* (How.), were previously recorded from immature scales by Thompson and Griffiths (1949), Muma (1955), and Griffiths and Thompson (1957). In rare instances *A. citrinus* appeared to be a factor in reducing scale infestations (Muma,1958, and unpublished data). However, these parasites and several predators studied by the same workers were generally unable to prevent scale increase, and insecticides were usually required for the control of this pest.

In June, 1958, a new parasitic wasp, *Aphytis lepidosaphes* Compere, was discovered attacking purple scale near Fort Pierce and was soon found to occur throughout peninsular Florida (Muma and Clancy, 1959; Clancy and Muma, 1959). This discovery prompted an extensive survey of the main citrus-growing areas to evaluate parasitism as a factor in the natural control of purple scale. The data presented herein are the result of this suvey.

METHODS

Eight essentially unsprayed groves were selected in each of the five major citrus-growing areas, and leaf samples were collected in January, April, July, and October for a two-year period. Ten purple scale-infested leaves were collected from each of the 40 groves at each visit for mass rearing of parasites to determine comparative parasite abundance. Another ten infested leaves were collected from 20 of these groves for microscopic examination to determine rates of parasitism.

Mass-rearing samples were examined under a dissecting microscope and other species of scale insects were removed insofar as possible. These samples were then placed in ice cream cartons fitted with plastic funnels and test tubes and maintained at 80°F. until the adult parasites had

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emerged and died. Each species was then counted and its relative abundance calculated.

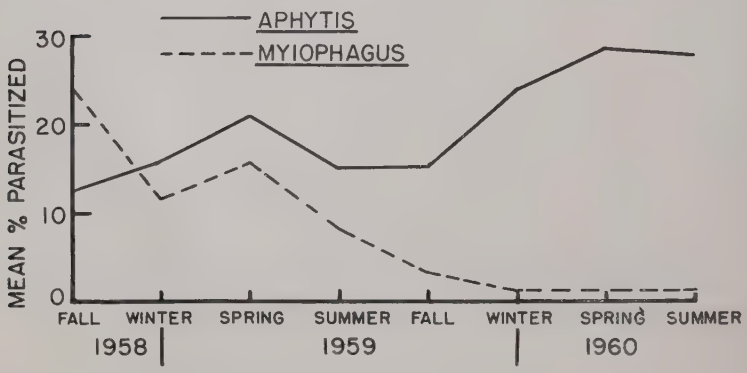
The remaining samples were examined under a dissecting microscope and each parasitized, healthy or previously parasitized scale was recorded. Individual records were taken for each stage and sex of the host and for each recognizable species of parasite. Parasitism rates were calculated from these data, and were based on healthy scales and scales containing some stage of the parasites.

Original determinations of the hymenopterous parasites were made by B. D. Burks of the U.S.N.M. and Harold Compere of the University of California. Parasitic fungi were identified by the criteria cited by Fisher et al. (1949 and Fisher 1950b).

Results

Parasitic Fungi.—Only the endoparasitic chytrid, *Myiophagus* sp., was recorded because the crawler disease associated with *H. besseyi* is considered of minor importance. The mortality of adult female scales caused by *Myiophagus* is shown in Figure 1. Disease incidence during the first six months of study approached the pattern previously recorded (Fisher et al., 1949) with peak infection occurring in the summer and fall during warm, wet weather and high host density. Since the spring of 1959, however, chytridiosus has steadily declined with no seasonal fluctuations. This condition has existed throughout the state.

FIG.1-PARASITISM OF ADULT FEMALE PURPLE SCALES BY APHYTIS LEPIDOSAPHES COMPERE & MYIOPHAGUS SP., FALL 1958 TO SUMMER 1960



Parasitic Hymenoptera.—Although all four primary parasites and the hyperparasite, *Thysanus flavopalliatus* (Ashmead), were reared, only

A. lepidosaphes, *A. lounsburyi*, and *A. citrinus* were sufficiently abundant to study. *P. aurantii* comprised 2.0 percent of the parasite population (Table 1) but was never reared from individually isolated scales nor recognized during microscopic examinations. *T. flavopalliatus* represented 3.1 percent of the parasite population (Table 1), but was seen only twice, attacking *A. lepidosaphes*.

TABLE 1.—Relative Abundance by Area and Season of Hymenopterous Parasites Reared from Purple Scale, Fall 1958 to Summer 1960.

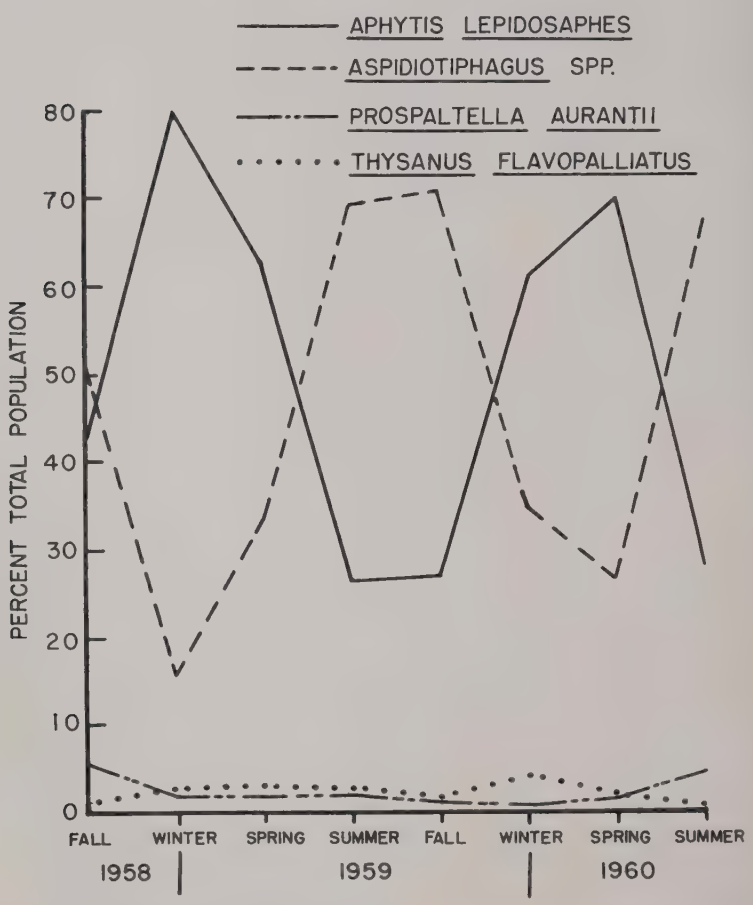
Area and Season	Percent of Parasite Population for Each Species				Number Samples
	Aphytis	*Aspidiotiphagus*	*Prospaltella*	*Thysanus*	
North	69.1	22.0	2.1	6.6	64
Central	60.9	30.9	3.9	4.1	62
South	42.3	53.1	0.5	3.9	63
East Coast	39.8	56.0	2.4	1.6	65
West Coast	44.7	53.2	1.2	0.7	66
Winter	73.7	21.8	3.0	1.4	80
Spring	64.5	31.1	2.6	1.8	81
Summer	27.4	67.5	1.3	3.6	78
Fall	39.2	55.4	1.0	4.3	81
Mean	51.3	43.4	2.0	3.1	

The newly discovered golden eulophid, *A. lepidosaphes*, comprised 51.3 percent of the parasite population, and was relatively more abundant in the northern and central areas, and during the winter and spring (Table 1 and Figure 2). The scales which produced this species were 96.4 percent adult females, 3.5 percent prepupal males and 0.1 percent second instar females. Although parasitism of adult female scales by *A. lepidosaphes* ranged from 0.0 to 100.0 percent, the seasonal means varied from 12.5 to 28.7 percent with parasitism highest in the winter and spring and lowest in the summer and fall (Figure 1). Figure 1 also shows that parasitism by *A. lepidosaphes* increased markedly during the study period. Parasitism counts did not reveal a geographic difference such as that indicated by the relative abundance of emerged adults.

The previously recorded brown and yellow eulophids, *A. lounsburyi* and *A. citrinus*, were recorded as a unit because species identification was dependent on microscopic examination. *Aspidiotiphagus* spp. represented 43.4 percent of the total parasite population and were relatively more abundant in the south, east coast, and west coast areas, and during the summer and fall (Table 1 and Figure 2). The scales from which these parasites emerged were 0.4 percent adult females, 10.2 percent second instar females and 89.4 percent prepupal males. Although parasitism of prepupal males by *Aspidiotiphagus* spp. ranged from 0.0 to 32.0 percent, the seasonal means

varied from 1.7 to 8.7 percent with parasitism highest in the summer and fall, and in the south and west coast areas.

FIG. 2-RELATIVE ABUNDANCE OF HYMENOPTEROUS PARASITES REARED FROM PURPLE SCALE SAMPLES,— FALL 1958 TO SUMMER 1960

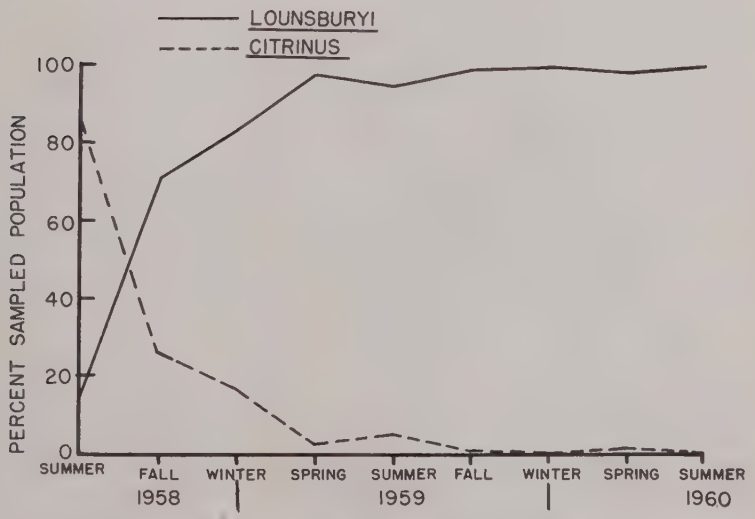


About 10 percent of the reared adult *Aspidiotiphagus* were mounted and examined microscopically to determine the relative abundance of the two species involved. As shown in Figure 3, *A. citrinus* represented about 85.5 percent of the original population, but was almost replaced by *A. lounsburyi*. This species reversal occurred during the first three months of the survey.

Discussion

This study of purple scale parasitism has been complicated by the biological natures of the several species of parasites. *Aphytis lepidosaphes* was the only external parasite found attacking purple scale. For this reason parasitism counts of *A. lepidosaphes* are believed to be reasonably accurate, whereas counts of the internal parasites, *Aspidiotiphagus* spp. and *Myiophagus* sp. are considered low because early stages could not be recognized. Furthermore, *A. lepidosaphes*, except for a single rearing from Glover scale, *Lepidosaphes gloverii* (Packard) has been taken only from purple scale, whereas the other hymenopterous parasites are known to attack several scale species. Adult rearings, therefore, may have been contaminated by *Aspidiotiphagus* spp. from other scales known to occur within purple scale clumps. Also, no comparable data were obtained for the fungus *Myiophagus* sp. Despite these limitations, the results indicate several facts concerning parasitism of purple scale.

FIG. 3 - RELATIVE ABUNDANCE OF ASPIDIOTIPHAGUS LOUNSBURYI (B. & P.) AND A. CITRINUS CRAW IN SAMPLES OF REARED PARASITES, SUMMER 1958 TO SUMMER 1960



The rapid decline and subsequent scarcity of purple scale in Florida citrus groves since 1958 (Simanton, 1960 and 1961) coincides with the discovery and increase of its parasite, *A. lepidosaphes*. Although present evidence is circumstantial, this parasite is believed to be responsible for the unprecedented recent reduction in purple scale infestations.

There are several reasons for this belief. First, the parasite attacks the critical adult female stage of the scale which was previously almost

free of parasitism, except by the fungus *Myiophagus* sp., during periods of high host density, temperature and moisture. Second, chytridiosus has been markedly reduced and shows no indication of recovering its previous sharp seasonal fluctuations. Third, *A. lepidosaphes* seems to have a highly developed host-finding capacity as it presently maintains high rates of parasitism despite extremely low scale populations. Four, *A. citrinus*, the only hymenopterous parasite previously known to be associated with scale decreases, has been largely replaced by *A. lounsburyi* which primarily "wastes" its attack on male scales. Fifth, although several predators are known to attack purple scale (Muma, 1955), little evidence of predation has been observed in scale infestations. In essence, the rate of attack by *A. lepidosaphes* has increased as purple scale infestation declined while attack by other known natural control agents has decreased.

Other possible reasons for the success of *A. lepidosaphes* include a short life cycle, which results in several generations of the parasite to each generation of the host, and adult feeding on non-parasitized scales, which results in additional scale mortality (Clausen, 1956), and its relative abundance in sprayed groves, which indicates tolerance to many pesticides (Simanton, 1961 and unpublished data).

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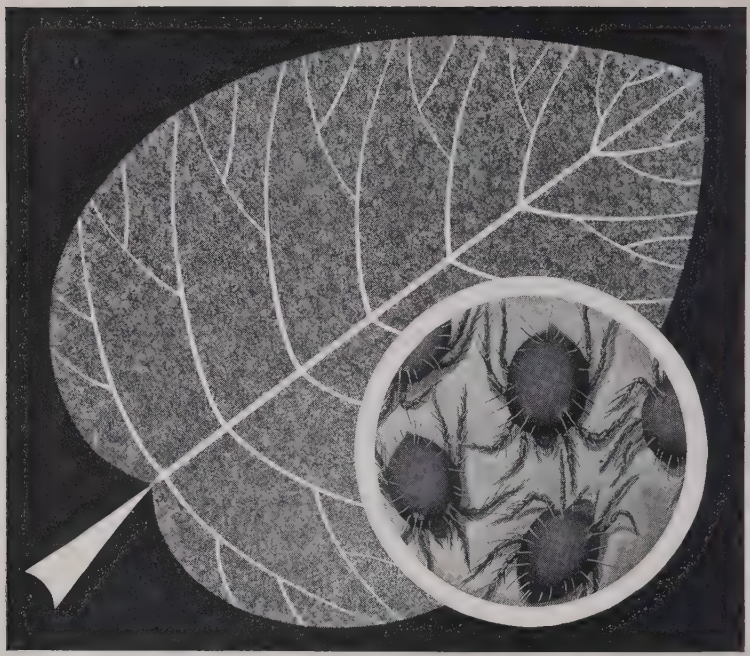

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NEW FALSE SPIDER MITES WITH NOTES ON SOME PREVIOUSLY DESCRIBED SPECIES (ACARINA: TENUIPALPIDAE)[1]

DONALD DE LEON
Erwin, Tennessee

Sixteen new species of false spider mites are described from Tennessee, North Carolina, Georgia, and Florida; the notes deal primarily with new host and distribution records for species collected chiefly in these states; one name, *Brevipalpus deleoni*, is synonymized.

All measurements are given in microns and body length includes the rostrum.

Brevipalpus dipholisi, n. sp.

(Figure 1, A and B)

Brevipalpus dipholisi belongs to the species group having five pairs of dorsolateral hysterosomal setae, palpus with 1 seta and a sensory rod at distal end of last segment, and tarsus II of the female with 1 sensory rod. Although it appears to be allied to the *lochmius-salviella* sub-group in having the rostrum reaching slightly beyond the distal end of femur I, it differs from these two species in having but the single seta at end of palp and all dorsal body setae short.

FEMALE: Body reddish pink, length 283, width 155; markings of dorsum and shapes of dorsal setae as shown in figure 1, A. Hysterosomal pores faint. Venter medially practically smooth anterior of posterior medioventral metapodosomals; area posterior of these two setae to genital plate transversely striate, ventral plate lacking anterior part of frame; genital plate with areolae wider than long. Posterior medioventrals much longer than anterior pair. Third segment (as well as fourth) of palp with 1 seta; seta of second segment short (7 microns). Rod of tarsus II slender, straight-sided, 7.7 long. Claws of tarsi with large hooks.

MALE: Resembles female, but tarsus II with 2 rods.

NYMPH: Shapes of dorsal setae as shown in figure 1, B.

Holotype: Female, Key Largo, Florida, October 16, 1958 (D. De Leon), on *Dipholis salicifolia*. *Paratypes:* 8 males, 4 nymphs, other data same as for holotype.

Brevipalpus obovoides, n. sp.

(Figure 2, A, B, and C)

The female *Brevipalpus obovoides resembles B. obovatus* Donn. (Pritchard and Baker, 1952) in number of dorsolateral setae, in having 1 rod on tarsus II and in the markings of the dorsum, but the palpus bears only 1 seta and a rod terminally and the markings of the venter are distinctive.

FEMALE: Length 292, width 155; markings of dorsum and shapes of dorsal setae as shown in figure 2, A. Hysterosomal pores faint in some specimens, not observed in others. Venter anterior of ventral plate, except

[1] Cost of engravings borne by a grant from the Pinellas Foundation, Inc., St. Petersburg, Florida.

coxal bases II, III, and IV, fully areolate, the areolae mostly in clusters of 2 to 8, spaces between clusters forming an irregular reticulate pattern; ventral plate with areolae similar to those anterior of it, but areolae arranged in nearly transverse rows; anterior part of frame composed of two bands; genital plate with areolae much wider than long, most of the areolae extending nearly the width of the plate. Posterior medioventrals much longer than the anterior pair. Rod of tarsus II slightly club-shaped, about 7 long; tarsal claws with large hooks. Seta of palp segment 2 short (10 microns), coarse, serrate.

MALE: Resembles female, especially in markings of venter and in having 1 rod on tarsus II. Seta of palp segment 2 slender and about 7 long.

NYMPH: Shapes of dorsal setae as shown in figure 1, B.

Holotype: Female, Key Largo, Fla., June 7, 1956 (D. De Leon), on *Forestiera porulosa*. *Paratypes:* 2 females, 1 male, 2 nymphs, other data same as for holotype; 2 females, 1 male, 1 nymph, Key Largo, Fla., November 22, 1958, on *Eugenia buxifolia*.

The following three species (*bumeliae, conocarpi*, and *pycnanthemi*) belong to the species group having six pairs of dorsolateral hysterosomals, 1 seta and a sensory rod at end of palp, the posterior medioventrals very much longer than the anterior pair, and tarsus II of the female with 1 sensory rod.

Brevipalpus bumeliae, n. sp.

(Figure 3, A and B)

Brevipalpus bumeliae is readily distinguished from other members of this group that have the dorsum with somewhat irregular reticulations as it lacks the anterior part of the frame of the ventral plate.

FEMALE: Body greyish with a tinge of red, length 242, width 143; markings of dorsum and shapes of dorsal setae as shown in figure 3, A; hysterosoma without observable pores. Venter smooth medially anterior of posterior medioventrals, area between these setae and genital plate with widely spaced, more or less transverse striae; genital plate with areolae much wider than long. Tarsus II with sensory rod 7 long, almost straight-sided; all claws with large hooks.

MALE: Resembles female, but tarsus II with 2 rods, the outer rod very long (11-14 microns), straight-sided.

NYMPH: Dorsal setae of shapes shown in figure 3, B. Dorsocentrals 3, if present, not found.

Holotype: Female, Key Largo, Fla., November 22, 1958 (D. De Leon), on *Bumelia* sp. *Paratypes:* 1 female, 2 males, 1 nymph, other data same as for holotype.

Brevipalpus conocarpi, n. sp.

(Figure 4, A and B)

Brevipalpus conocarpi is distinct from other members of this group in having the dorsum covered with mostly small (8-11 per 30 microns), rounded areolae; the female, like *bumeliae*, lacks the anterior part of the frame of the ventral plate.

FEMALE: Anterior part of propodosoma and legs whitish, rest of body red; length of body 266, width 149; markings of dorsum and shapes of dorsal setae as shown in figure 4, A; hysterosoma apparently without pores.

Venter smooth medially anterior of posterior medioventrals, area between these setae and genital plate more or less transversely striate, the areolae very much wider than long; genital plate with areolae mostly angular and somewhat wider than long. Rod of tarsus II 12.6 to 15 long, straight-sided; claws with large hooks.

MALE: Resembles female, but tarsus II with 2 rods.

NYMPH: Shapes of dorsal setae as shown in figure 4, B.

Holotype: Female, Coral Gables, Fla., July 19, 1955 (D. De Leon), on *Conocarpus erecta*. *Paratypes:* 6 females, 1 male, 2 nymphs, Coral Gables, Fla., July 22, 1955; 1 female, Key Largo, Fla., October 3, 1958.

Brevipalpus pycnanthemi, n. sp.
(Figure 5, A and B)

The female *Brevipalpus pycnanthemi* resembles *B. selas* P. and B. 1952. It differs most noticeably from that species in the markings of the venter, the male in having a single sensory rod and the nymph in having propodosonal 1 long and hysterosomal 5 minute.

FEMALE: Body bright red, length 304, width 176. Markings of dorsum and shapes of dorsal setae as shown in figure 5, A; areolae medially very closely placed, the lines of demarcation barely visible in some specimens; hysterosoma without distinct pores. Venter areolate medially, the areolae mostly small and rounded and mostly in clusters, the clusters irregular in shape; in some specimens areolae indistinct between anterior and posterior medioventrals. Ventral plate with small, rounded areolae, mostly in clusters; genital plate with areolae wider than long. Rod of tarsus II about 7 long, nearly straight-sided. Claws with moderate sized hooks.

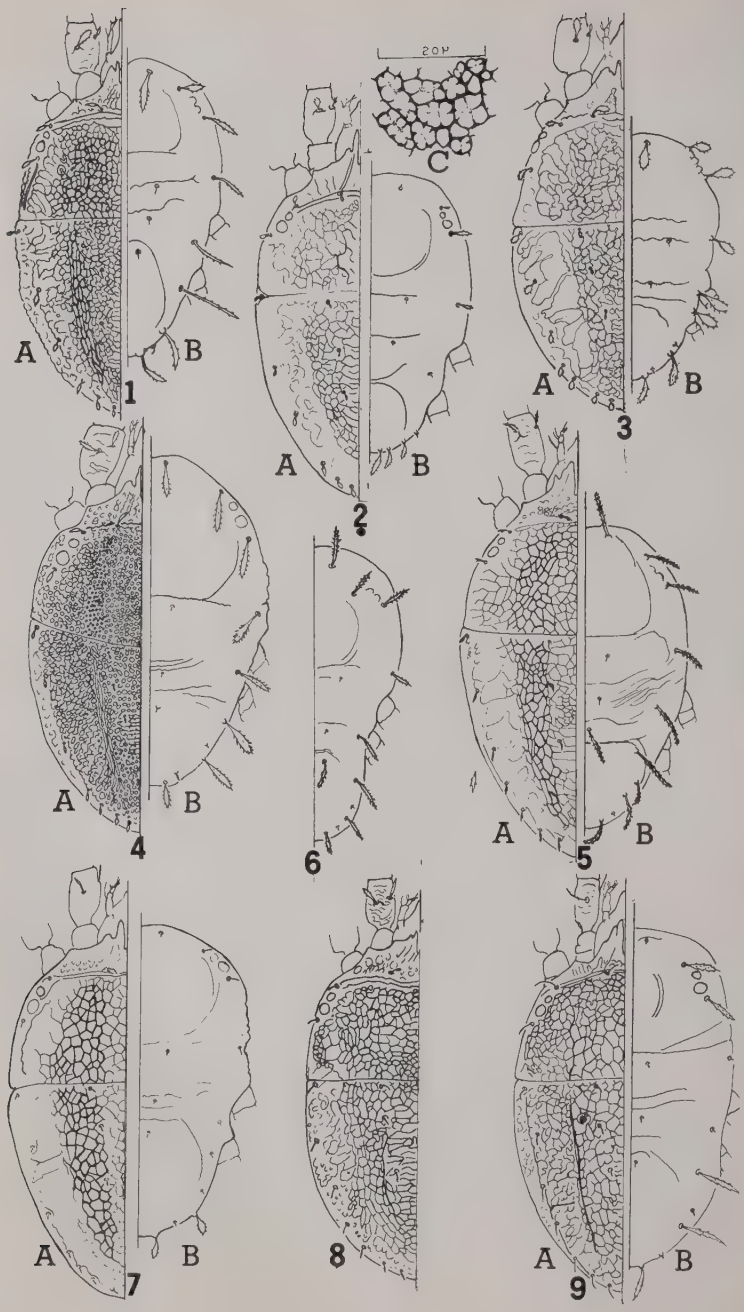
MALE: Resembles female, including length of rod of tarsus II.

NYMPH: Shapes of dorsal setae as shown in figure 5, B. Of 10 nymphs, 3 have one member of dorsocentrals 2 nearly as long as dorsocentrals 3.

LARVA: Resembles nymph, but dorsolateral 7 minute. Dorsolateral 9 is not flagelliform, but minute. Of 4 larvae, 1 has one member of dorsocentrals 2 nearly as long dorsocentrals 3.

Holotype: Female, Pensacola, North Carolina, August 22, 1958 (D. De Leon), on *Pycnanthemum pycnanthemoides*. *Paratypes:* 4 females, 3 males, 10 nymphs, other data same as for holotype. Specimens which apparently are a variety of *pycnanthemi* were collected from *Eupatorium serotinum* at Columbus, Georgia, August, 1956. The adults differ from those taken on *Pycnanthemum* in having the venter practically smooth and a shorter (4.9 long) and more club-shaped rod on tarsus II; the nymphs (figure 6) differ in having dorsolateral 7 minute and dorsocentrals 2 do not appear to be as variable since of 9 specimens all have both members of the pair minute, also the long dorsolaterals are somewhat shorter. It is proposed that specimens with these variations be called variety *georgianus*.

The following six species (*janeae, psychotriae, tiliae, lysilomae, styxus,* and *ocoteae*) have six pairs of dorsolateral hysterosomals, 2 setae and a sensory rod at the end of the palpus, the posterior medioventrals very much longer than the anterior pair (except *psychotriae*), and the female with 1 sensory rod on tarsus II.


A
B
1
C
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Brevipalpus janeae, n. sp.

(Figure 7, A and B)

Brevipalpus janeae resembles *B. essigi* Baker 1949 in the markings of the dorsum, but the rostrum is much shorter and the male and nymph differ.

FEMALE: Body rather bright red, length 293, width 165; markings of dorsum and shapes of dorsal setae as shown in figure 7, A; propodosoma and hysterosoma each with a pair of faint pores in some specimens, in others pores not seen; areolae medially very close together, the lines of demarcation faint in places. Venter medially with small rounded areolae, areolae mostly clustered in small groups; areolae faint in area between anterior and posterior medioventrals; ventral plate with rather large, regularly polygonal areolae; areolae of genital plate much wider than long. Rod of tarsus II about 5.6 long, straight-sided. Claws with large hooks.

MALE: Resembles female, but tarsus II with 2 rods.

NYMPHS: Shapes of dorsal setae as shown in figure 7, B.

Holotype: Female, Columbus, Georgia, August 29, 1956 (D. De Leon), on *Aureolaria flava* subsp. *reticulata*. *Paratypes:* 10 females, 2 males, 14 nymphs, other data same as for holotype; 7 females, 8 males, 4 nymphs, Columbus, Ohio, September 6, 1957, on *Weigela* sp. The specimens from Georgia were taken in association with *B. obovatus* Donn. The areolae on the venter of the adults from Ohio are somewhat less distinct than those on the specimens from Georgia. The species is named for Miss Jane Ellen Tyrrell of Columbus, Ohio, who was a little mite herself when she helped mount specimens of it.

Brevipalpus psychotriae, n. sp.

(Figure 8)

The female *Brevipalpus psychotriae* closely resembles *B. oncidii* Baker 1949, but differs from that species in being much smaller and in having most of the venter of the podosoma covered medially with small, rounded areolae. The male and nymph are unknown.

FEMALE: Body reddish yellow, length 304, width 175; markings of dorsum and shapes of dorsal setae as shown in figure 8; hysterosomal pores faint. Venter of propodosoma between apodemes 2 and posterior of medioventrals covered with very small, rounded areolae; metapodosoma medially

EXPLANATION OF PLATES

Plate 1

Figure 1. *Brevipalpus dipholisi*, n. sp. A, female; B, nymph.
Figure 2. *Brevipalpus obovoides*, n. sp. A, female; B, nymph; C, ventral areolae of female.
Figure 3. *Brevipalpus bumeliae*, n. sp. A, female; B, nymph.
Figure 4. *Brevipalpus conocarpi*, n. sp. A, female; B, nymph.
Figure 5. *Brevipalpus pycnanthemi*, n. sp. A, female; B, nymph.
Figure 6. *Brevipalpus pycnanthemi*, n. sp. Variety *georgianus*, nymph.
Figure 7. *Brevipalpus janeae*, n. sp. A, female; B, nymph.
Figure 8. *Brevipalpus psychotriae*, n. sp., female.
Figure 9. *Brevipalpus tiliae*, n. sp. A, female; B, nymph.

with small, rounded areolae; ventral plate with mostly small, rounded areolae arranged in more or less transverse rows, anterior part of frame of ventral plate composed of 2 to 3 bands; genital plate with areolae wider than long. Anterior and posterior medioventral metapodosomals short. Rod of tarsus II 7.7 long, straight-sided; genu IV with 1 seta. Claws with large hooks.

Holotype: Female, Key Largo, Fla., January 27, 1959 (D. De Leon), on *Psychotria* sp. *Paratype:* 1 female, other data same as for holotype.

Brevipalpus tiliae, n. sp.

(Figure 9, A and B)

The female *Brevipalpus tiliae* resembles *B. sayedi* Baker 1949 in markings of dorsum, but is larger, the rostrum is shorter, and the venter lacks the marked transverse striations. The nymph is also distinctive.

FEMALE: Body yellowish brown to pale apricot, length 298, width 165. Markings of dorsum and shapes of dorsal setae as shown in figure 9, A; hysterosomal pores very prominent. Venter practically smooth between anterior and posterior medioventrals, area posterior of these latter setae areolate, the areolae wider than long and arranged in more or less transverse rows; ventral plate with areolae similarly arranged; genital plate with aerolae wider than long. Rod of tarsus II 5.6 long, slightly club-shaped. Claws with large hooks.

MALE: Resembles female, but tarsus II with 2 rods; the outer rod appears to be slightly spiralled.

NYMPH: Shapes of dorsal setae as shown in figure 9, B.

Holotype: Female, Erwin, Tenn., August 31, 1960 (D. De Leon), on *Tilia heterophylla*. *Paratypes:* 13 females, 6 males, 4 nymphs, other data same as for holotype.

Brevipalpus lysilomae, n. sp.

(Figure 10, A and B)

The female *Brevipalpus lysilomae* resembles *B. xystus* P. and B. 1958 in having a rather long rostrum, but the dorsum lacks the striate pattern and the hysterosoma has a deep, narrow mediolateral groove; the nymph is also different. The male is unknown.

FEMALE: Body dark red, length 262, width 145. Markings of dorsum and shapes of dorsal setae as shown in figure 10, A; hysterosoma with very prominent pores. Rostrum in some specimens reaching about to, in others to slightly beyond distal end of femur I. Venter with area anterior of posterior medioventrals smooth, area between these setae and anterior part of frame of ventral plate with rather small, rounded areolae; ventral plate with rather small, rounded areolae; genital plate with irregularly shaped narrow areolae much wider than long. Rod of tarsus II distinctly club-shaped, about 4.9 long. Claws with large hooks.

NYMPH: Shapes of dorsal setae as shown in figure 10, B.

Holotype: Female, Key Largo, Florida, February 9, 1959 (D. De Leon), on *Lysiloma bahamensis*. *Paratypes:* 4 females, 3 nymphs, other data same as for holotype.

Brevipalpus styxus, n. sp.
(Figure 11, A and B)

Brevipalpus styxus resembles *B. lysilomae* in dorsal markings, but differs most noticeably in having a shorter rostrum and in the markings of the venter; the nymph also differs. The male is unknown.

FEMALE: Body dark brownish red, length 284, width 145-173. Markings of dorsum and shapes of dorsal setae as shown in figure 11, A; hysterosoma with distinct pores. Venter smooth or nearly so in a narrow area extending from ventral plate to a point about even with posterior medioventrals and then widening to an area somewhat wider than distance between anterior medioventral metapodosomals and extending forward to beyond medioventral propodosomals; lateral of the smooth area of the metapodosoma areolae distinct, moderately large and arranged mostly in longitudinal rows; ventral plate with areolae of about the same size as those at sides of smooth area, but arranged medially in transverse rows; genital plate with narrow areolae very much wider than long. Rod of tarsus II slightly club-shaped 5.6-6.3 long. Claws with moderate sized hooks.

NYMPH: Shapes of dorsal setae as shown in figure 11, B.

Holotype: Female, Delray Beach, Fla., September 9, 1956 (D. De Leon), on *Solanum bahamense*. *Paratypes:* 10 females, 1 nymph, other data same as for holotype.

Brevipalpus ocoteae, n. sp.
(Figure 12, A, B, and C)

Brevipalpus ocoteae resembles *B. formosus* De Leon 1960. The seta of the second segment of the palp is elliptic and the markings of the dorsum have the same general pattern; it differs most noticeably from *formosus* in being larger and more elongate, less strongly tuberculate, and in having the pitted mediodorsal area of the propodosoma much wider. The male is unknown.

FEMALE: Length 279, width 161. Markings of dorsum and shapes of dorsal setae as shown in figure 12, A; hysterosomal pores faint. Venter of metapodosoma, except for a small smooth, oval area between anterior medioventrals, medially with small, rounded areolae; ventral plate with small rounded areolae arranged in more or less transverse row; frame of ventral plate at sides unusually wide; genital plate with areolae much wider than long. Seta of second segment of palp elliptic, serrate. Rod of tarsus II about 7 long, straight-sided. Claws with large hooks.

NYMPH: Shapes of dorsal setae as shown in figure 12, B. Dorsolateral idiosomals 9 and 10 are minute, and 9 is ventral rather than dorsal.

LARVA: Shapes of dorsal setae as shown in figure 12, C.

Holotype: Female, Key Largo, Fla., February 18, 1959 (D. De Leon), on *Ocotea coriacea*. *Paratypes:* 2 females, 4 nymphs, other data as for holotype; 1 female, 1 nymph, 1 larva, Everglades National Park, Fla., March 19, 1959.

Brevipalpus fraxini, n. sp.
(Figure 13, A and B)

Brevipalpus fraxini belongs to the species group having 6 pairs of dorsolateral hysterosomals, 2 setae and a sensory rod on end of palpus, the

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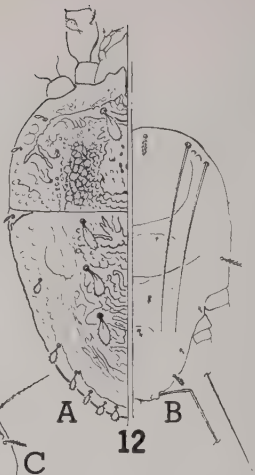

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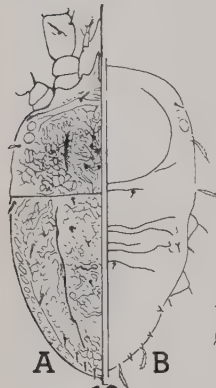

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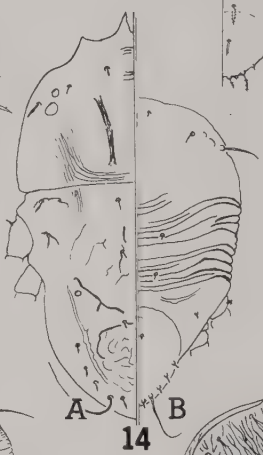

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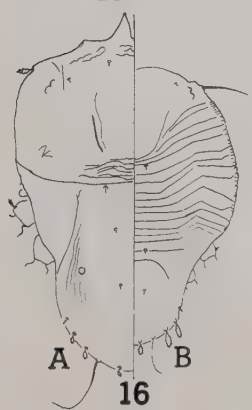

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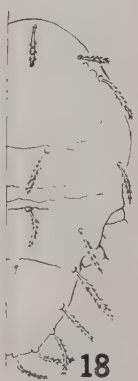
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posterior medioventral metapodosomals much longer than the anterior pair, and tarsus II of the female with 2 rods. The female is distinct from other members of this group in having the rostrum reaching to the distal end of femur I and the hysterosoma with a deep mediolateral groove. The male is unknown.

FEMALE: Body varying in color from dark grey to yellowish white; length 257, width 137. Markings of dorsum and shapes of dorsal setae as shown in figure 13, A; the narrow, convoluted areolae of the mediolateral area of the propodosoma in some specimens have many pits or hollows between them, in others the areolae adjoin each other more closely leaving no or only a few pits between them; in some specimens the propodosoma bears a pair of faint pores; the hysterosomal pores are prominent. Venter smooth in a narrow area between anterior and posterior medioventral metapodosomals, the area between these latter setae and frame of ventral plate with small oval and rounded areolae; ventral plate with similar areolae; genital plate with areolae much wider than long. Outer rod of tarsus II club-shaped, about 4.5 long. Claws with large hooks.

NYMPH: Shapes of dorsal setae as shown in figure 13, B. Propodosomal 1 and dorsocentral 2 not found, if present.

Holotype: Female, Columbus, Georgia, August 29, 1956 (D. De Leon), on *Fraxinus profunda*. *Paratypes:* 13 females, 5 nymphs, other data same as for holotype. The mites were numerous and appeared to be causing a bronzing of the leaves along the midrib and secondary veins; eggs were very common, salmon colored and were laid in among the hairs bordering the veins. Five female *Brevipalpus* collected on *Fraxinus* sp. at Fayetteville, Arkansas, July, 1957, and 6 females, 4 males, and 1 nymph collected on *Fraxinus* sp. at Harrisonburg, Illinois, August, 1957, resemble very closely the specimens from Georgia, but tarsus II of the female has only 1 rod and the areolae of the dorsum are on the whole somewhat smaller and more regular; the male has 2 sensory rods on tarsus II, the nymph resembles those from Georgia. Although further study may show otherwise, the difference in the number of rods on tarsus II of the females appears to be a non-specific variation as seems to be the case with *californicus* (Banks) (De Leon, 1961).

Tenuipalpus jussiaeae, n. sp.

(Figure 14, A and B)

Tenuipalpus jussiaeae resembles *T. punicae* P. & B. 1958, but differs from that species in having a single seta at end of palp, the dorsolateral

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EXPLANATION OF PLATES

Plate 2

Figure 10. *Brevipalpus lysilomae*, n. sp. A, female; B, nymph.
Figure 11. *Brevipalpus styxus*, n. sp. A, female; B, nymph.
Figure 12. *Brevipalpus ocoteae*, n. sp. A, female; B, nymph; C. larva.
Figure 13. *Brevipalpus fraxini*, n. sp. A, female; B, nymph.
Figure 14. *Tenuipalpus jussiaeae*, n. sp. A, female; B, nymph.
Figure 15. *Tenuipalpus guettardae*, n. sp. A, female; B. nymph.
Figure 16. *Tenuipalpus gumbolimbonis*, n. sp., A, female; B, nymph.
Figure 17. *Pentamerismus judiciarius*, n. sp., female.
Figure 18. *Brevipalpus colpodes* Pritchard and Baker, nymph.

setae shorter, and the dorsum of the propodosoma without a median ridge; the dorsolateral setae of the nymph are also shorter. The male is unknown.

FEMALE: Body bright red, length 279, width 158; markings of dorsum and shapes of dorsal setae as shown in figure 14, A. Venter with anterior medioventrals short, posterior pair long, both pairs nude; other ventral setae also nude. Palpus 3-segmented, the terminal segment with a single nude seta about 7 long, the second segment with a serrate seta about 7 long. Genua I and II each with 3 setae, 2 on the inner margin (a coarse seta dorsal of a thin seta) and 1 on the outer margin; genua III and IV bare.

NYMPH: Shapes of dorsal setae as shown in figure 14, B.

Holotype: Female, Everglades National Park, Fla., March 19, 1959 (D. De Leon), on *Jussiaeae* sp. *Paratypes:* 8 females, 13 nymphs, other data same as for holotype.

Tenuipalpus guettardae, n. sp.

(Figure 15, A and B)

Tenuipalpus guettardae resembles *T. japonicus* Nishio as redescribed by Ehara (1956); it differs most noticeably from that species by being much smaller and in having the propodosoma strongly ridged and rugose medially.

FEMALE: Body greenish to light yellow, length 240, width 134. Markings of dorsum and shapes of dorsal setae as shown in figure 15, A; rostrum reaching about to middle of femur I. Venter with a pair of short, nude anterior medioventrals and a pair of long, nude posterior medioventrals; inner pair of setae of genital plate very short (4.5 long), less than half as long as distance between their bases; outer pair about 3.5 long and about as long as distance to bases of inner pair. Palp apparently 3-segmented, the last segment with a terminal rod about 6 long; penultimate segment with a coarse, serrate seta about 10 long. Genua I and II each with a single seta (on inner margin), genua III and IV bare. Tarsi I and II each with a single sensory rod.

MALE: Length 226, width 121; body strongly constricted behind coxae IV and opisthosoma slightly narrowed behind dorsolateral I.

NYMPH: Shapes of dorsal setae as shown in figure 15, B. Dorsolateral opisthosomals, except DL 4, all less than 5 long. No hysterosomal pores observed.

Holotype: Female, Key Largo, Florida, October 16, 1958 (D. De Leon), on *Guettarda scabra. Paratypes:* 3 females, 2 males, 1 nymph, other data same as for holotype; 4 females, 2 nymphs, Everglades N. P., Fla., March 7, 1959, same host species.

Tenuipalpus gumbolimbonis, n. sp.

(Figure 16, A and B)

Tenuipalpus gumbolimbonis resembles *T. anoplus* B. and P. 1953 in general appearance, but differs from that species in having a seta on the outer margin of genua I and II, a seta on the anterior margin of coxa III, and in other characters; it differs most noticeably from *T. burserae* De L. 1957 in having the dorsum nearly smooth and a seta on genu III. The male is unknown.

FEMALE: Body reddish, length 260, width 177. Markings of dorsum and shapes of dorsal setae as shown in figure 16, A; dorsolateral hysterosomal 1 not found, if present. Venter with a single pair of short anterior medioventrals and a single pair of long posterior medioventrals; all ventral setae smooth and of normal lengths. Palpus 3-segmented, with a terminal rod; second segment with a coarse, serrate seta. Tarsi I and II each with a sensory rod and a short, coarse overlying guard seta; genua I and II each with 2 setae on inner margin (a short, coarse seta dorsal of a long, slender seta) and 1 seta on outer margin; coxa III and genua III each with a serrate seta on anterior margin.

NYMPH: Markings of dorsum and shapes of dorsal setae as shown in figure 16, B. Propodosomal 1 and hysterosomal 1 not found, if present.

Holotype: Female, Coral Gables, Fla., November 5, 1954 (D. De Leon), on *Bursera simaruba*. *Paratypes:* 14 females, November 5, 1954 and 4 females, 10 nymphs August 30, 1955, Coral Gables, on *B. simaruba;* 4 females Sept. 19, 1956, Coral Gables, on *Eugenia* sp. This is a very common species on *B. simaruba*.

Pentamerismus judiciarius, n. sp.

(Figure 17)

Pentamerismus judiciarius resembles *P. canadensis* McGregor 1949, but differs from that species in having propodosomals 1 and 2 large, the dorsal seta of femur I palmate-serrate, and in other characters. The male is unknown.

FEMALE: Length 305, width 182. Rostrum extending slightly beyond distal end of femur I; markings of dorsum and shapes of dorsal setae as shown in figure 17. The area between and slightly anterior of the third pair of dorsocentrals and extending to the posterior margin of the body practically smooth in some specimens. Ventral and genital plates smooth. Second segment of palp with a very slender seta; fourth segment with 2 setae, fifth with 2 setae and a sensory rod, other segments bare; femur I with a palmate-serrate dorsal seta, genua I and II each with a setiform seta dorsad and a similar seta on inner margin; tarsi I and II each with 1 sensory rod; claws with large hooks.

NYMPH: Similar to female, but propodosomals 1 and 2 much more slender.

Holotype: Female, Burnsville, North Carolina, October 16, 1957 (D. De Leon), on *Thuja occidentalis*. *Paratypes:* 3 females, 1 nymph, other data same as for holotype.

Types of the above species are in the author's collection.

The list below deals for the most part with new host and/or locality records. Old records are enclosed in parentheses.

Aegyptobia nothus P. and B. 1958: (*Taxodium distichum*), Everglades N. P., Fla., Jan., 1956; Paducah, Kentucky, Aug., 1957. (*Juniperus virginiana*), Norfolk Lake, Ark.; Harrisonburg, Ill. Aug., 1957.

Pentamerismus oregonensis McGregor, 1949: *Thuja orientalis*, Coral Gables, Fla., July, 1955.

Brevipalpus alternatus De L. 1961: (*Conocarpus erecta*), Coral Gables, Fla., July, 1955.

B. colpodes P. and B. 1958: *Iva imbricata,* (Miami, Fla.), April, 1955; *Solidago* sp., Florida City, Fla., Feb., 1959. The male and nymph were previously unknown; the male resembles the female, but has two rods on tarsus II; the dorsum of the nymph is shown in figure 18.

B. deleoni P. and B. 1958: Dr. E. W. Baker kindly examined the type series of mites under this name; he states (*in litt.*) that all the adults have two rods on tarsus II and are in other respects the same as *phoenicis,* and that the nymphs also are within the range of variation of *phoenicis* nymphs. *Brevipalpus deleoni* Pritchard and Baker is therefore a synonym of *Brevipalpus phoenicis* (Geijskes).

B. garmani Baker 1949: *Helianthus tuberosus, Solidago* sp., and *Convolvulus* sp., Columbus, Ohio, Aug., 1957; *Verbesina* sp., *Veronia* sp., and *Eupatorium* sp., Erwin, Tenn., Aug., 1960. The male has 2 rods on tarsus II.

B. glomeratus P. and B. 1958: *Quercus velutina, Ostrya virginiana,* and *Hamamelis virginiana,* Erwin, Tenn., Aug., 1960.

B. ogmellus P. and B. 1958: *Quercus velutina,* Fayetteville, Ark., July, 1957; *Q. marilandica,* Poplar Bluff, Missouri, Aug., 1957.

B. sayedi Baker 1949: (*Carya* sp.), Columbus, Ohio, Aug., 1957; (*Carya illinoensis*), Columbus, Georgia, Aug. 1956. The male has 2 rods on tarsus II.

Tenuipalpus anoplus B. and P. 1953: *Cedrela odorata,* Nov., 1954 and *Rhizophorus mangle,* April, 1955, (Coral Gables, Fla.).

T. bakeri McG. 1949: *Psychotria undata,* Key Largo, Fla., Dec., 1958.

T. carolinensis Baker 1945: *Smilax bonanox,* Fayetteville, Ark., July, 1957. This mite had not been collected since the original specimen was taken in South Carolina. Females and nymphs, which occurred in numbers, are pearly white; the dorsal setae of the deutonymph resemble those of the female in size and shape. No males were seen.

T. celtidis P. and B. 1958: (*Celtis* sp.), Paducah, Kentucky, Aug., 1957.

T. dasples B. and P. 1953: *Serenoa repens,* Everglades N. P. Fla., Feb. 1959; *Paurotis wrightii,* (Coral Gables, Fla.), Sept., 1956; (*Sabal* sp.) Boutte, La., Dec., 1956.

T. meekeri De L. 1957: (Fern), Everglades N. P., Fla., March, 1959.

Acknowledgments

I wish to thank the following botanists for the identification of many of the host plants: Dr. Harry Muegel, University of Cincinnati; Dr. A. J. Sharp, University of Tennessee; Dr. J. W. Hardin, North Carolina State College, and Prof. Erdman West, University of Florida.

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NOTES ON THREE NORTH AMERICAN APHIDIDAE

D. Hille Ris Lambers
Bladluisonderzoek T.N.O., Bennekom, Holland

As aphids have frequently been transported to other continents with cultivated plants, and therefore may be known in different continents under different names, the author while working on European aphids, was obliged to give attention to material from the North American continent. The following notes are the results of such studies.

Xenopterygus ipomoiae Smith, 1948 = *Geopemphigus surinamensis* H.R.L., 1933

C. F. Smith (1948) described the genus *Xenopterygus* with *Xenopterygus ipomoiae* as the type. He stated that the genus was most closely related to the Fordini but that many of the characters resemble those of the Prociphilini. Only the alate morphs are described. Through the kindness of Professor Smith I was able to examine paratype material and Professor A. N. Tissot most kindly gave me two more slides from the type collected at the type locality on June 11, 1945. In one of the type slides I detected an aptera vivipara and after remounting a number of alatae it was also possible to study their embryones.

It is clear from this material that *Xenopterygus ipomoiae* Smith, 1948 is identical with *Geopemphigus surinamensis* H.R.L., 1933, described from apterae and larvae found by Dr. Buntschli in Surinam on the roots of weeds. The typical structure of the anal portion resembles that in exules of *Baizongia* Rond., which is figured in the original description for an aptera. It is quite the same in the alatae found in Florida and no difference can be found between apterae from Surinam and the aptera from Florida. *Xenopterygus ipomoiae* Smith becomes a synonym of *Geopemphigus surinamensis* H.R.L.

The position of the genus *Geopemphigus* H.R.L., 1933, was obscure but after studying the alate Florida material it is possible to place it correctly.

The wax glands have no central hair but stand near a hair, which is quite typical for the Fordini but not for the Prociphilini. The structure of the underside of the head, the presence of rhinaria with a hairy fringe in alatae, and the occurrence of two hairs on the first tarsal joints of first instar larvae clearly define the genus as nearly related to *Baizongia* Rond. Of *Baizongia* only alate migrants from galls on Pistacia and the very different sexuparae were known, but a viviparous alate exul was reared which differs from sexuparae only in the rostrate embryones in its body. The alate *Xenopterygus* are also virginoparous exules: the embryones in their body have developed mouthparts. In other Fordini alate exules, as far as they are known also are indistinguishable in morphology from sexuparae. A paper by Dr. A. Davatchi (1958) contains an excellent treatment of Fordini, but if one tries to find out where our genus belongs with Davatchi's keys, he gets confusing results. The key to sexuparae leads to *Baizongia* Rond. The abdominal tergites have very distinct sclerotic bands and the cauda has about six hairs. But according to the first instar larvae present in the colonies from Surinam and from the embryones in the

Florida alatae one comes to the conclusion that the larvae belong to *Asiphonella* Theob., because their antennae have five segments and on the abdomen each tergite has two pairs of marginal hairs. In all alate *Baizongia* Rond. the primary rhinaria are only partly fringed: the one on the last and the penultimate antennal segment have only a lateral fringe over not more than about half the circumference of the rhinaria; the secondary rhinaria are quite nude. In *Geopemphigus*, however, both the primary and secondary rhinaria have a very distinct hairy fringe and in this respect agree perfectly with *Asiphonella* Theobald. Summing up we can state that *Geopemphigus* H.R.L. is very nearly related to *Asiphonella* Theob. and *Baizongia* Rond. but that it differs from both in several important characters.

As all the relatives of *Baizongia* Rond. hibernate as eggs on *Pistacia* spp. one may reasonably conclude that *Geopemphigus* H.R.L. is also associated with a gallforming aphid on *Pistacia*. Although members of the genus *Pistacia* are indigenous to America no aphids or aphid galls seem to have been recorded from these hosts, and on the other hand no aphid on *Pistacia* from the Palaearctic region is known that might be associated with the species under discussion.

Amphorophora minima Mason, 1925

This species was described from a single alate specimen. Through the kindness of Professor G. W. Simpson I was permitted to study and remount the type. The slide showed a terribly shrunken and twisted aphid which could hardly be studied, but after clearing and remounting it regained its original shape and appeared to be *Capitophorus hippophaes* (Wlk., 1852), of which *Amphorophora minima* Mason, 1925, becomes a synonym.

Adactynus tutigula Hottes, 1933

During an aphid hunt in Colorado with Dr. F. C. Hottes, it was found that the autumn population of this species on *Corydalis* sp. consisted of very few, old, apterae viviparae, great numbers of alatae, alatoid nymphs and alate males, besides one rather abnormal ovipara. Such a composition of an aphid population in the autumn clearly indicates that the species has host alternation. As the species, which Gillette and Palmer (1934), Hottes (1949), and Palmer (1952) placed in *Kakimia* Hottes and Frison, 1931, has five hairs on the first tarsal joints, it should be easy to recognize it on its primary host plant if morphs from that host plant had been found.

In the same area, some ten miles away, alate gynoparae, adult oviparae and large numbers of immature apterous larvae were found on the undersides of leaves of a wild *Rosa* sp. The alate gynoparae and the oviparae agree perfectly with the alatae and the ovipara taken on *Corydalis*. A search on roses in Utah by Professor Knowlton provided us with one aptera from a wild rose taken in spring. Therefore it is clear that the species shows host alternation between *Rosa* as primary host plant and *Corydalis* as secondary host plant. I transfer the species from *Kakimia* to *Acyrthosiphon* Mordvilko, 1914.

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RELATIVE SUSCEPTIBILITY OF FOUR SPECIES OF MOSQUITOES TO INSECTICIDE RESIDUES

G. C. LaBrecque, J. B. Gahan, and H. G. Wilson
Entomology Research Division, Agric. Res. Serv., U.S.D.A.

Strains of mosquitoes resistant to chlorinated hydrocarbon insecticides have been discovered in many areas where intensive control programs have been conducted (Brown, 1958). In most instances organophosphorus insecticides have satisfactorily re-established control. Some vigor tolerance to the organophosphorus compounds by the resistant mosquitoes has been noted, but to date no cross-resistance has been reported. Often a toxicant effective against one species may be less effective against another. Residual tests were made with four species of mosquitoes to determine their relative susceptibility to Bayer 29493 (Baytex; *O,O*-dimethyl *O*-[4-(methylthio)-*m*-tolyl] phosphorothioate), DDT, and malathion.

The mosquitoes were reared in laboratory colonies and included a strain of *Aedes aegypti* (L.) that had no previous exposure to insecticides, a strain of *Anopheles quadrimaculatus* Say known to be resistant to dieldrin, but not to DDT, a strain of *Aedes taeniorhynchus* (Wied.) that was resistant to DDT (Davis et al., 1959), and a strain of *Anopheles albimanus* Wied. that exhibited resistance to DDT and dieldrin when collected in El Salvador, but has not been subjected recently to insecticide pressure. The first three colonies were reared at Orlando, Florida; the *albimanus* were generously provided by L. E. Roseboom and J. H. Hobbs from a colony maintained at Johns Hopkins University.

The three insecticides were tested against one- to two-day-old adults of the four species in duplicate tests. Acetone solutions were sprayed on plywood panels at the rate of 100 and 10 mg. of the toxicant per square foot. Enough panels were sprayed to avoid the necessity of using the same surface twice. In each test 20 to 40 mosquitoes under half sections of Petri dishes were exposed to the treated panels for periods ranging from 1 to 120 minutes. The insects were then transferred to cylindrical screen cages and provided with a 10% honey solution in cotton pads and mortality counts were made after 24 hours. Thirty-minute knockdown counts were also taken after each exposure up to 30 minutes. Evaluation of species susceptibility was based on a comparison of the exposure times needed to obtain 90 to 100% mortality in 24 hours. The results are given in Table 1.

Aedes aegypti was the most susceptible species to these three compounds. The ten-mg. deposits of Bayer 29493 and malathion produced 90 to 100% mortality of *aegypti* after exposures as short as one minute, but a 15-minute exposure was required to obtain the same result with DDT. Against *taeniorhynchus*, *quadrimaculatus*, and *albimanus*, Bayer 29493 was the most toxic compound and malathion was superior to DDT. Differences between the susceptibilities of these three species were minor but *taeniorhynchus* was slightly more susceptible than the others to Bayer 29493 and *quadrimaculatus* to DDT.

The 100-mg. deposits of all three compounds and the ten-mg. deposits of malathion and DDT produced 100% knockdown of *aegypti* within 30 minutes following one or more of the exposures. Complete knockdown of *taeniorhynchus* was also obtained with the 100-mg. deposit of malathion. None

TABLE 1.—Effectiveness of Three Insecticides as Residues on Plywood Panels Against Four Species of Mosquitoes.

Residue (mg./sq. ft.)	Exposure (min.)	*aegypti*		*taeniorhynchus*		*quadrimaculatus*		*albimanus*	
		Percent knockdown in 30 min.	Percent kill in 24 hrs.	Percent knockdown in 30 min.	Percent kill in 24 hrs.	Percent knockdown in 30 min.	Percent kill in 24 hrs.	Percent knockdown in 30 min.	Percent kill in 24 hrs.
Bayer 29493									
100	1	0	100	0	100	0	51	5	100
	5	3	100	0	100	3	100	4	100
	15	0	100	0	100	9	100	0	100
	30	100	100	—	—	0	100	—	—
10	1	0	100	0	77	—	—	11	67
	5	3	100	0	100	2	45	0	42
	15	0	100	0	100	12	100	0	100
	30	54	100	0	100	0	100	0	100
Malathion									
100	1	15	100	—	—	2	6	0	9
	5	100	100	0	61	4	24	0	59
	15	100	100	50	100	21	97	0	100
	30	—	—	100	100	4	100	12	100
	60	—	—	—	—	—	100	—	—
10	1	0	92	—	—	—	—	0	25
	5	52	100	0	13	0	2	0	12
	15	56	100	0	100	6	88	0	57
	30	100	100	21	100	0	100	6	100
	60	—	—	—	—	—	100	—	100

TABLE 1.—Continued.

Residue (mg./sq. ft.)	Exposure (min.)	*aegypti*		*taeniorhynchus*		*quadrimaculatus*		*albimanus*	
		Percent knockdown in 30 min.	Percent kill in 24 hrs.	Percent knockdown in 30 min.	Percent kill in 24 hrs.	Percent knockdown in 30 min.	Percent kill in 24 hrs.	Percent knockdown in 30 min.	Percent kill in 24 hrs.
					DDT				
100	1	0	0	—	—	—	—	0	6
	5	47	90	—	—	11	21	0	68
	15	100	100	0	8	16	59	0	73
	30	100	100	50	13	18	100	54	76
	60	—	—	—	78	—	—	—	100
	120	—	—	—	100	—	—	—	—
10	1	5	27	—	—	—	—	—	—
	5	43	86	—	—	—	—	—	—
	15	100	100	0	0	0	29	0	22
	30	100	100	0	0	10	37	0	70
	60	—	—	—	8	—	100	—	58
	120	—	—	—	100	—	—	0	100

of the compounds caused more than 54% knockdown of the two *Anopheles* species in 30 minutes.

Some vigor tolerance to the organophosphorus insecticides was indicated by the three resistant strains, but not to such a degree as to indicate cross-resistance or to reduce the effectiveness of the insecticides.

Summary

Residual tests were made with four species of mosquitoes to determine their comparative susceptibility to DDT, malathion, and Bayer 29493 (Baytex; *O,O*-dimethyl *O*-[4-(methylthio)-*m*-tolyl] phosphorothioate). *Aedes aegypti* was the most susceptible species. Differences between the susceptibilities of *Aedes taeniorhynchus*, *Anopheles albimanus*, and *Anopheles quadrimaculatus* were slight.

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NOTES ON THE DISTRIBUTION AND ECONOMIC IMPORTANCE OF *TOMASPIS BICINCTA* (Say)[1]

AVERETT S. TOMBES AND BOBBY C. PASS[2]

Several authors have recorded that *Tomaspis bicincta* (Say) is distributed in the southeastern states, except in Mississippi and South Carolina; along the Atlantic Coast states to Massachusetts; and into the midwest to Kansas and Oklahoma (Doering, 1930, and personal correspondence; Osborn, 1921). Only a few references concerning its economic importance have been made in the literature. Halloway and Loften (1919) observed it as a rare pest on sugar cane, and this conclusion was again confirmed 30 years later by Ingram et al. (1951). Fifield and Genung (1955) reported that this species was observed injuring Pangola grass in the Everglades in Florida and had also been found on most of the common pasture and weed grasses in southern Florida. The purpose of this note is to record the presence of this species in South Carolina and to mention briefly its economic importance.

State records indicate that this insect has been collected from several locations in South Carolina since 1926. In the last decade its distribution has become almost statewide; however, not until 1957 was there any record of its being of economic importance. At that time it was observed in large populations on coastal bermuda grass and it was suspected of causing considerable damage to the stand. This observation was substantiated by Swift (1958) following experimentation under greenhouse conditions. At that time sufficient evidence was obtained to question whether the plant's injury was a result of insect feeding or whether it was a condition resulting from the introduction of an insect product into the plant.

Biological investigations of *Tomaspis bicincta* (Say) are presently underway as well as studies on the development of a control program using inseticides with short residual properties. A program is also planned to evaluate physiologically the effect of the insect on the host plant.

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[1] Considered by R. G. Fennah (1953) to be *Prosapia bicincta* (Say).

[2] Assistant Entomologist and Graduate Assistant respectively, Department of Entomology and Zoology, Clemson College, Clemson, South Carolina.

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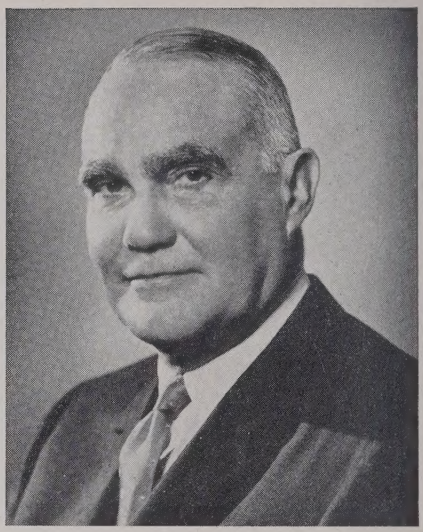

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